Claims

5 ~~A new method for determining in-situ bulk tortuosity of the interconnected pores~~ A new method for determining the in-situ Slow-wave or Drag-wave velocity (both these waves representing the same phenomenon) of permeable reservoir rock formations which are continuous between two wellbores, and from that determination, using the existing known mathematical relationship to 10 calculate the bulk tortuosity of the interconnected pores of reservoir rock, and estimating the bulk permeability of a reservoir formation between seismic transmitters and seismic receivers, such method comprising 1-5 ~~7~~ below (currently amended):

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15 1. (Currently amended) Transmit a mono-frequency signal generated by a seismic transmitter or seismic transmitters in a wellbore and received by a seismic receiver or seismic receivers in another or the same wellbore.

2. (Previously amended) Analyze the spectral content of the received signal.

20

3. (Previously amended) Identify the side lobes of the mono-frequency signal that was transmitted.

4. (Previously amended) The frequency of the side lobes represents (F - Fdrag) and (F + Fdrag), where F is the mono-frequency and Fdrag is the frequency of the 'Drag Wave'; these side lobes are generated due to the elastic nonlinear interaction between the mono-frequency wave traveling through the rock matrix and the 'Drag Wave' being generated due to the coupling between the matrix and pore fluids.

Sub C1

31

5. (Previously amended) Calculate the velocity of the 'Drag Wave' Vdrag by using the Doppler Effect in which Fdrag/F = Vdrag/(V – Vdrag); where Fdrag is the frequency of the 'Drag Wave' (see 4 above), F is the mono-frequency, Vdrag is the velocity of the 'Drag Wave' and V is the velocity of the mono-frequency signal.

6. (Withdrawn) ~~The bulk tortuosity of the inter-well reservoir rock formation can be estimated by: Vdrag = Vfluid/√T, where Vdrag is the velocity of the 'Drag Wave', T is tortuosity, and Vfluid is the compressional velocity of the pore fluids.~~

7. ~~Once bulk tortuosity has been estimated, bulk permeability can be estimated using Scheidegger's equation $K = \phi r^2 / 8T$ or other equations generated by Kelder or Peeters.~~

6. ~~8.~~ (Currently amended) The method of claims 1-5 ~~1-7~~ specifically used to determine in-situ bulk tortuosity of the interconnected pores of reservoir rock, and estimating the bulk permeability of a reservoir formation connected between two wells (Amended).

B1 End Sub 5 C1

7. ~~9.~~ (Currently amended) The method of claims 1-5 ~~1-7~~ specifically used to determine in-situ bulk tortuosity of the interconnected pores of reservoir rock, and estimating the bulk permeability of a reservoir formation in a well between two depth points in that well (Amended).